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ALGAE AND WATER SUPPLIES IN THE SAO PAULO AREA

C. Mervin Palmer

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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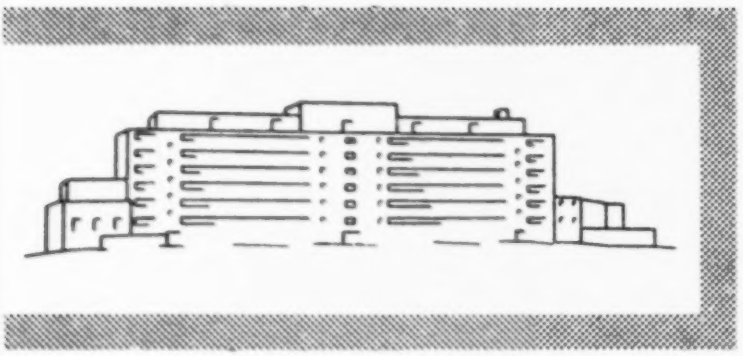

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ALGAE AND WATER SUPPLIES OF THE SÃO PAULO AREA

This report consists of the English text of an article published in the Brazilian journal Revista D.A E.: "Algas e suprimento de agua na area de São Paulo." Revista, Departamento de Aguas e Esgôtos de São Paulo. Ano XXI, No. 37: 11-15. Junho 1960. It was prepared while the author was on assignment from the Public Health Service to the International Cooperation Administration, U.S.A., Operations Mission to Brazil, Point IV, Division of Health and Sanitation. It is published with the permission of the above journal.

C. Mervin Palmer
Aquatic Biologist

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control

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ALGAE AND WATER SUPPLIES OF THE SÃO PAULO AREA

As part of the three-month assignment in Brazil the writer was requested to make a study of the algae in Billings, Guarapiranga, and other reservoirs and supplies representing the sources of the public water supplies of the São Paulo area. Advice was also desired on the possible significance of any potentially toxic algae such as Microcystis and Anabaena in Billings Reservoir. Finally, recommendations were requested concerning methods of preventing and controlling problems caused by algae.

Billings Reservoir has been of particular interest since it receives water containing city sewage and industrial wastes and has developed extensive algal blooms. Guarapiranga Reservoir is expected to be used for an increasingly large portion of the city water supply and, therefore, any evidence of increasing enrichment with greater algal problems would be important.

For the water supply problem as a whole, some information was wanted on the algae in other water sources, such as those at Cotia, Cantareira, Casa Grande, and Campinas.

The São Paulo area study was carried out between December 17, 1959, and March 4, 1960, with about five weeks of that time being used for other assignments in Rio de Janeiro, Belo Horizonte, and São Paulo. The study involved trips to reservoirs and treatment plants for observation and for collections of samples, the laboratory examination of samples for numbers and kinds of algae, the study of previous records and information pertinent to the problem, and consultations with individuals in charge of, or otherwise concerned with the particular water supplies. All of these were made possible through the cooperation of officials of the Departamente de Águas e Esgôtos de São Paulo, and particularly through the untiring efforts and interest of Dr. Estanislau Blumberg, Chief of the Central Laboratory of the Division of Treatment.

Report on Billings Reservoir and ABC Treatment Plant

Five trips were made to the Billings Reservoir, one of them including an inspection by launch from the dam to the intake towers of the power plant. On three of the trips water samples were collected at three locations at and near the ABC plant intake tower and at four depths: surface, 1 meter, 5 meters, and 1/2 meter from the bottom. The treatment process at the ABC plant was also observed.

From the trip made on December 22, it was observed that much of the reservoir had visible blue-green growths of the alga Microcystis (Anacystis) at the surface with numerous areas showing denser accumulations or blooms of the algae. The portion of the reservoir near the dam appeared to be free of the alga and was brownish and very turbid.

Microcystis was present as readily visible blooms around and near the intake tower of the ABC plant. The density of the bloom was greatest in December and decreased during January and February. The bloom was concentrated at the water surface with much less growth present below the top ten centimeters of water. The uneven distribution of the bloom over the surface was probably due to wind and water currents which caused the algae to aggregate in certain areas. Unfortunately one of these areas frequently affected was that around the intake tower.

The ABC treatment plant is new and modern and appears to be functioning well in water treatment. During January and February activated carbon was being added 6 - 8.8 p.p.m. at a point just following the addition of the coagulant. This may be the only plant in Brazil where activated carbon is being used. The raw water had a slight grassy to musty odor which appeared to be absent or much less evident in the treated water. No threshold odor tests or other odor tests are made on any routine basis by the plant. Algal growths on the walls of the basins in the treatment plant were not evident and the whole plant showed evidence of continuous successful work on the part of the personnel in charge to keep the plant clean, sanitary, and functioning well.

Microscopic analysis of water samples from Billings Reservoir near the ABC intake indicates that with increasing distance from the water surface the number of kinds of algae increases while the total count and the numbers of Microcystis colonies decreases. In January the total count was approximately 4000 to 5000 algae (clump count) per ml.

This is high compared with other reservoirs in São Paulo. However, there are numerous water supplies in North America where the count is frequently as high or higher.

The genera of algae most commonly encountered were Microcystis (Anacystis), a 2-celled minute form (unidentified) Gonyaulax, Melosira, Tetraedron, Peridinium, Staurastrum, Chlorella, and Scenedesmus. The diatom Melosira has a reputation as a filter-clogger, while Staurastrum (a desmid), the dinoflagellates, and Microcystis are important in taste and odor production. Anabaena was reported as common in November but was not abundant during the period December-February. Microcystis and Anabaena are blue-green algae which are found in some lakes and ponds to be toxic to animals.

A study of monthly plankton records for Billings Reservoir for the previous year indicates that the blooms of blue-green algae are seasonal, Anabaena being abundant in November while Microcystis (Anacystis) follows in December and gradually decreases through January and February. These algae tend to be absent or few in the winter, when a mixed group of green algae, flagellates, and diatoms predominates.

While it would be desirable in a number of ways, to have a raw water supply free of large growths of algae, especially blue-green algae, many cities in America are confronted with supplies where algae are a problem to be dealt with either seasonally or throughout the year. Proper treatment of such waters for use requires an adequate treatment plant, competent and responsible personnel, and field and laboratory data, including frequent plankton counts to aid in making adjustments in the normal treatment procedures and in the use of algicides.

As is the case with other cities which have to cope with seasonal blooms of blue-green algae, there is no convincing evidence of serious illness in the community caused by use of such water after adequate treatment. However, the potential danger caused by the presence of these algae has to be realized and all precautions taken to reduce the risk. At the same time, research needs to be stimulated which could give more knowledge of the physiology of toxic algae. Effective safeguards and control measures could then be sought for.

The following suggestions are made concerning procedures for treatment of water with algal growth of the type found at the ABC plant:

Continue to keep the treatment plant in excellent working condition so that it will be accurate and effective in

the chemical dosage, coagulation, sedimentation, removal of sludge, and in sand filtration.

Continue to keep the plant clean and sanitary.

Increase the amount of activated carbon used for odor control when tests indicate its need.

Collect data on a regular routine basis on plankton in the raw water. A competent person could be trained by Mr. Branco to do this. There is already at the ABC plant a microscope satisfactory for this work.

Collect plankton data on partially treated and treated water sufficient to serve as a basis for modifications in chemical and physical treatment which would improve the processes of coagulation, sedimentation, and sand filtration for removal of algae.

Experiment with the use of copper sulphate in the raw water particularly at the time when the blue-green algae show signs of increasing in numbers in September, October, and November.

During the period of algal blooms, erect a vertical surface barrier, extending down about 1/2-1 meter and located perhaps 15-30 meters from the intake towers, to prevent the wind from forming blooms of surface algae in the area near the intakes.

Press for all measures which will reduce the entrance of algal nutrients and potential nutrients into Billings Reservoir. The most significant pollutant in this respect is undoubtedly city sewage.

Report on Guarapiranga Reservoir and its Treatment Plants

Four trips were made to the reservoir and the treatment plants through which the reservoir water passes. One of these included a motor boat ride of several hours during which water samples were collected for microscopic analysis, and an inspection of a considerable area of shore line was made for evidence of sources of pollution.

The portion of the reservoir studied had a sparse algal growth over most of the area. The plankton count was less than 1000 algae (clump count) per ml, at all depths, and even the stone rip-rap on the dam was free of attached growths of filamentous algae. This absence of marginal growths could possibly be due to the use of herbicides for the control of aquatic weeds at the swimming beaches, or to the changing level of the water. Except for the area near the dam, the

water was very turbid due to silt, which also reduces plankton growth to a minimum due to the absence of sunlight in the water.

Algae were common only near the shore where it was enriched by drainage from farms having animals such as hogs, cattle and horses, or by drainage from a section of shore used by a large flock of buzzards. Occasional swampy areas did not have the expected development of shallow water algae.

Guarapiranga Reservoir thus appeared to be, itself, relatively free of nuisance algae. The most common genera included the diatoms Stephanodiscus, Melosira and Synedra, the green algae Botryococcus, Mougeotia, and Spirogyra, the blue-green alga Oscillatoria, and the flagellate Euglena. Except for the diatoms, most of these were generally localized in the areas of enrichment.

Due to such factors as lack of urban development along much of the shore, the presence of a drainage area which mostly is not rich in algal nutrients, and finally the high turbidity due to silt, the algal population of Guarapiranga reservoir was sparse during the period of December 1959 to March 1960. An increase in the human population around the reservoir and a decrease in turbidity could, of course, markedly alter the growth of algae in the future.

A considerable growth of attached algae was present on the walls of the canal and basins of the pre-treatment plant located near the dam, which receives water from the reservoir. This is an indication that the reservoir water under certain environmental conditions is capable of harboring abundant growths of algae. These algae could readily be the cause of tastes and odors in the water as well as reducing the length of filter runs and reducing the retention period for chlorine residual in the distribution system.

Report on Other Water Supplies for São Paulo

Trips were made to Cotia reservoirs and treatment plant and to Cantareira water sources and settling basins as well as to the Cabuçú Treatment Plant for observation and for collection of water samples and algal growths. A planned trip to Casa Grande water source and reservoir had to be cancelled because rains made the roads impassable.

The two reservoirs at Cotia contained low to moderate numbers of plankton algae, no visible blooms of algae, and only small growths of marginal algae. The most common algae

in the larger, more remote reservoir (Pedro Beicht) were Melosira, Dictyosphaerium, Microcystis (Anacystis), Gonyaulax, Cryptomonas, and Selenastrum. In the smaller reservoir, located between the larger one and the treatment plant, and known as Graca reservoir, the more common algae included Melosira, minute pigmented flagellates, Dinobryon, Botryococcus, Glenodinium, and Cosmarium. A number of the algae are known as taste and odor producers. The raw water had a slight but distinct grassy odor.

Continuous copper sulphate treatment was being applied to the water, with a dosage of 1 p.p.m., just before it reached the treatment plant sedimentation basins. Attached marginal growths of algae were visible on some walls of the sedimentation basins. The sand filters were in need of repairs and were out of use. Undoubtedly the Cotia water could be improved by passage through a well-functioning sand filter.

The two reservoirs are well located in a forested, non-agricultural area and with no human habitations on the shores as sources for enrichment with algal nutrients. Data from frequent routine plankton analyses would be useful in determining when and if algicide treatment of portions of the reservoirs should be carried out to reduce the development of larger numbers of particular kinds of taste and odor algae such as Dinobryon.

In the settling basins at Cantareira some attached and surface algae, mostly Oedogonium, were present. However, the most significant algal growth was undoubtedly that of the diatom Synedra which was present in large numbers in the plankton. Besides reducing the effectiveness of chlorine treatment, this diatom often produces an earthy-musty odor in water and is effective in clogging filters. If routine plankton counts were made, the time for treatment with copper sulphate could be determined in order to prevent the development of large numbers of this diatom. The other most common algae at Cantareira included Gomphonema, Anabaena, Cryptomonas, Phormidium, and minute pigmented flagellates.

At the Cabuçú Treatment Plant, the most abundant algae in the untreated water were Melosira and Uronema. Prominent cracks that were present in the sand beds of the filters could have been produced at least in part, by the clogging of the sand surface by algae.

A cursory examination of concentrated samples of treated water taken from several areas of the São Paulo supply indicated that the algae present in each reflected the algal flora of the raw water source for each of the areas. Plankton analyses of the treated water are often useful in checking the effectiveness of the treatment at each plant for removal of algae. Algae present in distribution systems may eventually decompose to give rise to tastes and odors, to reduce the residual chlorine, and to serve as nutrients for the development of heterotrophic organisms in the pipes.

Acknowledgments

In addition to the aid and cooperation from Dr. Blumberg and others, referred to earlier, it is desired to acknowledge the assistance of Mr. Samuel Murgel Branco, Aquatic Biologist in the Division. His competent aid, suggestions, and cooperation, as well as his records of previous plankton studies formed an essential part of this study and is highly appreciated. Arrangements for all of the trips for laboratory work, and for introductions to the many officials and others involved were all made by Dr. Estanislau Blumberg, to whom the writer is particularly indebted. The writer considers it a real privilege to have the acquaintance and friendship of the many persons who made his sojourn in São Paulo so pleasant and so rewarding.

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